

Notes on lichenized fungi of chroodiscoid *Thelotremataceae* from China

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ABSTRACT—Chinese collections representing eleven species in four genera of lichenized chroodiscoid *Thelotremataceae* are reviewed taxonomically. Four species—*Astrochapsa platycarpella*, *Chapsa patens*, *C. diploschistoides*, *C. pulchra*—are reported as new records for China. Each new record is described, illustrated, and discussed in detail. Descriptions and remarks are also provided for the other seven species previously reported from China—*Astrochapsa mirabilis*, *Chapsa indica*, *C. leprocarpa*, *Chroodiscus argillaceus*, *Reimnitzia santensis*, *Rhabdodiscus asiaticus*, and *Xalocoa ocellata*.

KEY WORDS —*Graphidales*, *Ostropomycetidae*, *Lecanoromycetes*

Introduction

The most recent taxonomic concept of lichen forming *Lecanoromycetes* accepts the resurrected family *Thelotremataceae* Stizenb. in *Graphidales* (*Ostropomycetidae*; Kraichak & al. 2018, Lücking 2019). In *Thelotremataceae* ascomata are true apothecia with hemiangiocarpous development, where crater-like apothecia form their double margin from the cupulate proper exciple and an outer thallus layer (= thalline margin; Matsumoto 2000, Frisch 2006). The characteristics of proper exciple, thalline margin, columella structures, carbonization, and other features determine five types that describe the considerable differences in apothecial morphology: *Chroodiscus*-type, *Fibrillitheces*-type, *Myriotrema*-type, *Ocellularia*-type, and *Thelotrema*-type (Frisch 2006). The *Chroodiscus*-type apothecia, referred to as chroodiscoid by Hale (1981), are rounded, reniform, angular or star-shaped, and usually large

with a distinctly exposed disc surrounded by a jagged, fissured, or lobed (rarely entire) margin that is erect to recurved or exfoliating (Frisch 2006, Mangold 2008). The chroodiscoid genera in *Thelotrema* are: *Acanthotrema*, *Astrochapsa* Parnmen & al., *Asteristion*, *Chapsa* A. Massal., *Cruentotrema*, *Chroodiscus* (Müll. Arg.) Müll. Arg., *Enigmatrema*, *Gyrotrema*, *Gintarasia*, *Myriochapsa*, *Nitidochapsa*, *Pseudochapsa*, *Reimnitzia* Kalb, *Rhabdodiscus* Vain., and *Xalocoa* Kraichak & al.

The literature has reported seven species—*Astrochapsa mirabilis*, *Chapsa indica*, *C. leprocarpa*, *Chroodiscus argillaceus*, *Reimnitzia santensis*, *Rhabdodiscus asiaticus*, and *Xalocoa ocellata*—from China (see below). During our recent research and compilation of FLORA LICHENUM SINICORUM, additional small genera (e.g., *Carbacarthographis*, *Myriotrema*, *Schizotrema*) have been described from China. (Jia & al. 2017, Liu & al. 2018, Xu & al. 2016, Jia & Lücking 2020). We report here on specimens collected from Fujian and Hainan provinces that represent four *Astrochapsa* and *Chapsa* species new to China: *A. platycarpella*, *C. patens*, *C. diploschistoides*, and *C. pulchra*.

Materials & methods

The specimens are deposited in the Fungarium of College of Life Sciences, Liaocheng University, China (LCUF). An Olympus SZX16 dissecting microscope and a Olympus BX53 compound microscope were used for morphological studies. Measurements were taken from mature cross sections of fruit bodies mounted in water. Ascospore amyloidity was tested using Lugol's solution. Spot tests were performed on the thallus surface with K (10% KOH aqueous solution), C (saturated aqueous NaOCl solution), and PD (saturated p-phenylenediamine solution in 95% ethyl alcohol). The lichen substances were detected and identified by thin-layer chromatography, using solvent C (Culberson & Kristinsson 1970, Culberson 1972, White & James 1985, Jia & Wei 2016).

Taxonomy (Four new records for China)

Astrochapsa platycarpella (Vain.) Parnmen, Lücking & Lumbsch,
PLoS One 7(12): e51392, 9 (2012)

FIG. 1A–C

THALLUS crustose, corticolous, brown-olive, smooth or uneven to warty. APOTHECIA scattered to aggregate in groups, level with the thallus, angular-rounded, 0.5–1.5 mm diam. MARGIN thin, lobulate to recurved, sometimes fused with a white pruinose inner surface. DISC exposed, pale brown to blackish, with distinct and coarse bluish white pruina. PROPER EXCIPLE fused, brown at the base; periphysoids $\leq 35\ \mu\text{m}$ long, free. HYMENIUM clear, 50–100 μm high; paraphyses unbranched, straight, 1.5–2 μm wide, tips slightly

thickened, with brownish granules. ASCI clavate, $50\text{--}90 \times 7\text{--}9 \mu\text{m}$, 8-spored. ASCOSPORES hyaline, transversely septate, $4\text{--}6$ -loculate, $15\text{--}18 \times 4\text{--}5 \mu\text{m}$, thin walled to slightly thickened at the edges of the lumina, with distal oblong ends tapering, I–.

CHEMISTRY: Thallus K–, C–, PD–; no lichen substances detected by TLC.

SPECIMENS EXAMINED: CHINA. HAINAN PROVINCE, Ledong County, Mt. Jianfengling, Yulingu. alt. 630 m, on bark, 10-XII-2019, M. Li HN19362, HN19365, HN19368, HN19377, HN19382 (LCUF).

ECOLOGY & DISTRIBUTION: In China on bark in an evergreen tropical rain forest. Distributed in Africa, South America, and India (Frisch 2006; Joshi et al. 2018). New to China.

REMARKS: *Astrochapsa platycarpella* is very close to *A. astroidea* (Berk. & Broome) Parnmen & al. but differs in having aggregated apothecia, a bluish white pruinose disc and white pruinose marginal lobules with solitary to fused apothecia, grayish pruinose discs, and rarely layered lobules. Mangold (2008) synonymised *Chapsa platycarpella* under *C. astroidea*, but Parnmen & al. (2012) transferred them both to *Astrochapsa* as separate species. *Chapsa alborosella* (Nyl.) Frisch is also similar but has an ecorticate thallus, dispersed apothecia, and 5–9-septate ascospores.

Chapsa diploschistoides (Zahlbr.) Frisch, Biblioth. Lichenol. 92: 99 (2006) FIG. 1D–F

THALLUS crustose, corticolous, pale to dark olive-grey or brownish, slightly uneven to warty. APOTHECIA dispersed, level with the thallus, rounded to angular, 0.5–1 mm diam. MARGIN thick, raised, deeply fissured to lobed, incurved to upright, often in two or three separate layers. DISC slightly exposed, pale brown, covered by thin white pruina. PROPER EXCIPLE deeply cupulate, hyaline to pale brown at the base; periphysoids $\leq 20 \mu\text{m}$ long, free. HYMENIUM clear, 70–90 μm high; paraphyses unbranched, straight, 2–2.5 μm diam, tips indistinctly moniliform and often a slight dendroid branching, adspersed with fine brownish granules. ASCI narrowly clavate, $70\text{--}85 \times 8\text{--}12 \mu\text{m}$, 8-spored. ASCOSPORES hyaline, transversely septate, 6-locular, $18\text{--}25 \times 5.5\text{--}6.5 \mu\text{m}$, thin walled, with subacute ends, I–.

CHEMISTRY: Thallus K–, C–, PD–; unknown lichen substances detected by TLC.

SPECIMEN EXAMINED: CHINA. HAINAN PROVINCE, Changjiang County, Mt. Bawangling, Yajia. alt. 650 m, on bark, 08-VII-2019, Y.H. Ju HN19163 (LCUF).

ECOLOGY & DISTRIBUTION: In southern China on bark in a tropical forest near a valley waterfall. Also known from South Africa (Frisch 2006). New to China.

REMARKS: *Chapsa diploschistoides* is similar to *C. alborosella* but differs by its thicker, fissured to fissured-areolate thallus with distinct warts, a more compact and glossier thallus surface, and apothecia with an incurved layered margin having a compact (not white-felty) inner surface. Our Chinese material has smaller ascospores than that from south Africa noted by Frisch (2006; $20\text{--}33 \times 6\text{--}7 \mu\text{m}$).

Chapsa patens (Nyl.) Frisch, Biblioth. Lichenol. 92: 111 (2006)

FIG. 1G–I

THALLUS crustose, corticolous, greenish grey, often somewhat brownish, slightly uneven to warty. APOTHECIA dispersed, level with the thallus, rounded to slightly angular, 1–2.5 mm diam. MARGIN thick, strongly raised, deeply fissured to lobed, incurved to upright but usually not strongly recurved in the apical parts. DISC exposed, pale brown, covered by thick and coarse white pruina. PROPER EXCIPLE deeply cupulate, hyaline to pale brown at the base; periphysoids $\leq 50 \mu\text{m}$ long, free. HYMENIUM clear, 130–200 μm high; paraphyses unbranched, straight, 2–2.5 μm diam, tips strongly moniliform and intensely adspersed with fine brownish granules. ASCI clavate, $100\text{--}180 \times 25\text{--}40 \mu\text{m}$, 1-spored. ASCOSPORES hyaline (slightly brownish in age), densely muriform, $80\text{--}120 \times 20\text{--}30 \mu\text{m}$, thin walled, with rounded ends, with a narrow halo, I–.

CHEMISTRY: Thallus K–, C–, PD–; no lichen substances detected by TLC.

SPECIMENS EXAMINED: CHINA. FUJIAN PROVINCE: Qianzhou City, Mt. Jiuxian, Huizhaochi. alt. 1540 m, on bark, 25–VII-2019, F.Y. Liu FJ19127-1, FJ19128-1, FJ19131, FJ19148-2 (LCUF).

ECOLOGY & DISTRIBUTION: In southern China on bark in a subtropical forest. Widely distributed in Africa, Japan, Sri Lanka, and India (Matsumoto 2000, Frisch 2006, Joshi & al. 2012). New to China.

REMARKS: *Chapsa patens* is similar to *C. leprocarpa*, which differs by having a slightly lower hymenium and smaller ascospores ($65\text{--}85 \times 15\text{--}23 \mu\text{m}$; see Chinese material of *C. leprocarpa*, below). Hale (1981) and Matsumoto (2000) described *C. patens* as having stictic acid, while Frisch (2006) noted that the lectotype definitely lacks stictic acid. The ascospores of *C. patens* in our Chinese collection are slightly smaller than those from Africa ($90\text{--}158 \times 22\text{--}35 \mu\text{m}$; Frisch 2006) and India ($80\text{--}125 \times 20\text{--}35 \mu\text{m}$; Joshi & al. 2012).

Chapsa pulchra (Müll. Arg.) Mangold,

Flora of Australia 57(Lichens 5): 654 (2009)

FIG. 1J–L

THALLUS crustose, corticolous, thin, pale gray to pale grayish-green, smooth to usually rough. APOTHECIA scattered, level with the thallus,

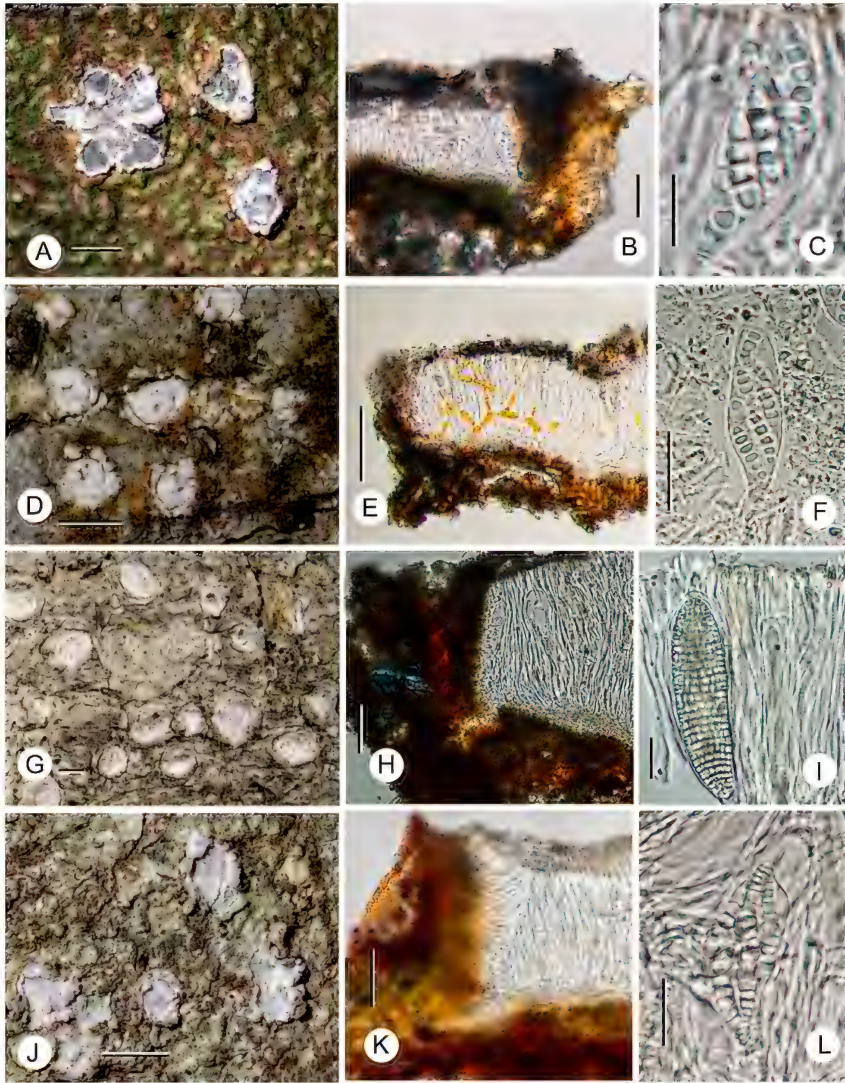


FIG.1 *Astrochapsa platycarpella* (LCUF – Li HN19365): A: habit; B: apothecial section; C: ascus containing ascospores. *Chapsa diploschistoides* (LCUF – Ju HN19163): D: habit; E: apothecial section; F: ascus containing ascospores. *Chapsa patens* (LCUF – Liu FJ19131): G: habit; H: apothecial section; I: ascus containing one muriform ascospore. *Chapsa pulchra* (LCUF – Li HN19422): J: habit; K: apothecial section; L: ascus containing ascospores. Scale bars: A, D, G, J = 1 mm; B, E, H, K = 50 μ m; C, F, I, L = 20 μ m.

roundish to irregular, 1–2 mm diam. MARGIN thick, lobed to eroded, rarely slightly layered, pruinose, becoming erect to recurved. DISC partly to entirely visible from surface, pale flesh-colored to grayish, with distinct pruina. PROPER EXCIPLE fused, brown at the base; periphysoids $\leq 30\ \mu\text{m}$ long, free. HYMENIUM clear, 100–130 μm high; paraphyses unbranched, straight, 1.5–2 μm diam, tips slightly thickened. ASCI clavate, $80\text{--}100 \times 10\text{--}18\ \mu\text{m}$, 6- or 8-spored. ASCOSPORES hyaline, transversely septate, 12–20-loculate, $30\text{--}65 \times 5\text{--}7\ \mu\text{m}$, thin walled to slightly thickened at the edges of the lumina, with distal oblong ends tapering, I–.

CHEMISTRY: Thallus K–, C–, PD–; no lichen substances detected by TLC.

SPECIMEN EXAMINED: CHINA. HAINAN PROVINCE: Ledong County, Mt. Jianfengling, Yulingu. alt. 630 m, on bark, 10-XII-2019, M. Li HN19422 (LCUF).

ECOLOGY & DISTRIBUTION: In southern China on bark in an evergreen tropical rain forest. Previously known only from Australia (Mangold 2008). New to China.

REMARKS: The species is very similar to *Chapsa indica*, which produces much larger ascospores with more septa (see below). Another similar species is *Chapsa alborosella* (Nyl.) Frisch, which is distinguished by smaller ascospores with fewer septa (5–9-septate, $17\text{--}22 \times 3\text{--}6\ \mu\text{m}$; Mangold 2008).

Seven other thelotrematoid species known from China

Astrochapsa mirabilis (Zahlbr.) Lücking & S. Joshi,
Lichenologist 50(6): 633 (2018)

The species is characterized by a corticate olive-green to greyish green thallus, angular apothecia with recurved margins, greyish disc covered with thick white pruina, carbonized exciple, inspersed hymenium, 8-spored asci, brown muriform 8–10/3–4-loculate ascospores measuring $40\text{--}50 \times 11\text{--}15\ \mu\text{m}$, and stictic acid.

Reported from Fujian Province of China (Zahlbruckner 1930, Jia & Lücking 2017) and India (Joshi et al. 2018). Pantropical Asia.

Chapsa indica A. Massal., Atti Reale Ist. Venet Sci. Lett. Arti., Sér. 3, 5: 257 (1860).

The species is characterized by the small angular or shortly elongated apothecia with a usually densely white-felty disc, *Chapsa*-type paraphyses and periphysoids, large hyaline transversely septate 18–35-loculate ascospores ($65\text{--}100 \times 5.5\text{--}8\ \mu\text{m}$), and the absence of lichen compounds. Its apothecia, ascospore type, and lichen compounds are similar to *C. pulchra*, which differs by its smaller ascospores (see above).

Reported from Hainan Province of China (Xu & al. 2016). Distributed mainly in Africa (Sierra Leone, Kenya, Mozambique), Asia (India, Sri Lanka, Borneo, Malaya, Andaman Islands), and Australia (Patwardhan & Nagarkar 1980; Nagarkar & al. 1986, 1988; Frisch 2006; Mangold 2008). Pantropical, extending to subtropical regions.

Chapsa leprocarpa (Nyl.) Frisch, Biblioth. Lichenol. 92: 108 (2006).

The species is characterized by the chroodiscoid apothecia with lobed and recurved margins, white heavily pruinose disc, one solitary muriform ascospore per ascus ($60\text{--}85 \times 15\text{--}23 \mu\text{m}$), and absence of lichen compounds. It is similar to *Chapsa patens*, which is distinguished by larger ascospores (see above).

Reported from Guangxi Province of China (Xu & al. 2016). Distributed mainly in Africa, Sri Lanka, India, Borneo, USA, Brazil, and Australia (Hale 1981, Sipman 1993, Frisch 2006, Mangold 2008). Pantropical, extending to subtropical regions in both hemispheres.

Chroodiscus argillaceus (Müll. Arg.) Lücking & Papong,
Bryologist 112(1): 154 (2009)

The species is characterized by a grayish green thallus, immersed to erumpent apothecia with recurved margins, flat opened dark grey discs, 8-spored asci, colorless ellipsoid 3-septate ascospores ($6\text{--}10 \times 2.5\text{--}3 \mu\text{m}$), and absence of lichen substances. It is similar to *Chroodiscus khaolungensis* Papong & Lücking, which has larger ascospores ($18\text{--}24 \mu\text{m}$; Papong & al. 2009, Wang & Wei 2018).

Reported from Hainan Province of China (Wang & Wei 2018). Distributed mainly in Southeast Asia (Papong & al. 2009).

Reimnitzia santensis (Tuck.) Kalb, Mycotaxon 79: 325 (2001)

The species is characterized by a thallus with large columns of calcium oxalate crystals and abundant isidia, chroodiscoid ascomata, brown submuriform ascospores ($15\text{--}25 \times 8\text{--}12 \mu\text{m}$), pycnidia with bacilliform conidia, and absence of lichen substances.

Reported from Zhejiang Province of China (Dou & al. 2019). Pantropical (Kalb 2001, Frisch 2006, Mangold 2008).

Rhabdodiscus asiaticus (Vain.) Rivas Plata, Lücking & Lumbsch,
Taxon 61(6): 1175 (2012)

= *Thelotrema formosanum* Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 24 (1933)

The species is characterized by its greyish to olive thallus, semi-emergent apothecia, thick brownish to distinctly carbonized proper exciple, well-

developed carbonized columella, 8-spored asci, transversely septate to indistinctly submuriform hyaline (occasionally pale brownish) ascospores ($10\text{--}40 \times 7\text{--}12 \mu\text{m}$), and psoromic acid.

Rhabdodiscus asiaticus resembles *R. fissus* (Müll. Arg.) Vain., which differs in having smaller brown submuriform ascospores. Aptroot (2004) listed *Thelotrema formosanum* as a synonym of *Ocellularia asiatica* [$\equiv R. asiaticus$], noting that its Taiwanese type had been erroneously cited as “Asahina no. 330” [correctly TNS Asahina F230], and that psoromic acid (TLC; PD+ deep yellow) was detected from the thallus, the ascospores are I+ violet, and the columella is conspicuous, simple, and visible from the outside.

Reported from China’s Taiwan Province (Zahlbruckner 1933, as *Thelotrema formosanum*; Wang-Yang & Lai 1973, as *T. formosanum*; Aptroot 2004). Distributed mainly in Vietnam and India (Vainio 1907, Joshi et al. 2018). Pantropical Asia.

Xalocoa ocellata (Fr.) Kraichak, Lücking & Lumbsch,
Austral. Syst. Bot. 26(6): 472 (2013)

The species is characterized by the greyish to pale yellow thallus, sessile discoid lecanoroid apothecia (1–2 mm diam.), grayish pruinose disc, thick non-carbonized proper exciple, 8-spored asci, ellipsoid muriform 3–5/0–2-septate brown ascospores ($15\text{--}30 \times 7.5\text{--}15 \mu\text{m}$), and norstictic acid.

Xalocoa ocellata resembles *Diploschistes cinereocaesius* (Sw.) Vain., which differs by its larger (≤ 3.6 mm diam.) apothecia, and lecanoric acid with traces of diploschistesic acids.

Reported from Yunnan and Sichuan Provinces (Zahlbruckner 1930, as *Diploschistes ocellatus*). This species is cosmopolitan (Kraichak & al. 2013).

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